Title: Agronomic and economic assessment of cover crop effects on irrigated wheat productivity and quality under double minimum tillage and raised bed planting systems

Research Overview

- **Institution**: Seed and Plant Improvement Institute
- **Project Duration**: 4 years and 6 months
- **Lead Researcher**: Mohammad Reza Mehrvar

Problem and Significance

In dense irrigated wheat systems, the following challenges were addressed:

- Soil erosion and low organic carbon
- Uneven nutrient layering and increasing weed resistance
- Poor crop rotation and short fallow periods

To solve these, long-term conservation agriculture practices were evaluated—especially with summer-sown green manure cover crops, retained wheat residues, reduced tillage using disc harrows, raised bed wheat planting, and short summer fallow systems.

Field Implementation Strategy

Applied consistently for three growing seasons:

- No burning; residue and weed biomass returned to the soil
- Seedbed prepared using disc harrow only
- Cover crops seeded mid-August; wheat planted mid-November
- No fertilizers or pesticides used for cover crops
- Weekly irrigation for cover crops using well water
- Rehabilitation of 20% of corn-sown land annually using cover crops

Agronomic Results

- Wheat yield improved from 6760 to 8489 kg/ha—a 24% increase
- Soil carbon rose from 0.45% to 0.81%; organic matter from 0.78% to 1.40%
- Enhanced nutrient retention, soil porosity, and water-holding capacity
- Water efficiency improved: irrigation use dropped from 0.77 to 0.61 m^3/kg wheat

- Doubling of irrigation intervals due to better soil structure

Top Performing Cover Crop Systems

- Forage millet: 9518 kg wheat/ha
- Sudangrass sorghum: 9029 kg wheat/ha
- Mung bean & rapeseed: 8918 kg wheat/ha

Economic Results

- Additional average yield: +4165 kg/ha over 4 years
- Combined cost of wheat + cover crop production: 145 million IRR/ha
    - 93.6% allocated to wheat production
- Net income: 111.1 million IRR/ha over 4 years
- Highest income from millet system: 124.1 million IRR/ha
- Average sales return: 39.2%; ROI: 64.6%
- Millet system ROI: up to 73.1%

Environmental and Farmer Impact

- Observable improvements within 60 days of cover crop introduction
- Benefits equal to those expected from multi-year crop rotations
- Farmers more likely to adopt due to early and visible positive results

Biomass Findings

- Dry biomass ranged from 1067 kg/ha (barley) to 12000 kg/ha (Sudangrass)
- Fresh biomass peaked at over 71,000 kg/ha (berseem clover)
- Biomass incorporated before flowering or at early bloom stages

Cover crops were ranked based on soil improvement potential and wheat productivity. The system promotes biodiversity through diverse cover crop integration and forms a sustainable model for raised-bed irrigated wheat production.